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13. Sticking probabilities have been measured for molecular chlorine upon the GaAs(100) Ga-rich c(8x2), GaAs(100) As-rich c(2.8), and GaAs(110) stoichiometric (1x1) surfaces. The sticking probability has measured as a function of incident translational energy (0.038 to 0.66 eV), surface temperature (150 K - 835 K), angle of incidence (0° to 37°), and surface chlorine coverage. Our data indicate the presence of both precursor and direct activated chemisorption mechanisms on all three surfaces. Total energy scaling is observed on both the GaAs(100) Ga-rich c(8x2) surface and the stoichiometric GaAs(110) (1x1) surface for both precursor mediated and direct activated chemisorption, indicating a highly corrugated gas - surface interaction potential. For all incident energies dosing of the 300 K GaAs(100) Ga-rich c(8x2) and stoichiometric GaAs(110) (1x1) surface results in chemical passivation; conversely dosing the 300 K GaAs(100) As-rich c(2.8) surface or the disordered GaAs(100) or GaAs(110) surfaces results in thermal etching. The chemical passivation of GaAs by Cl_2 is stable in air and may represent a significant technological advance; after the passivation layer has been further characterized for long term air stability.

Final Report on AFOSR-89-0390

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Sticking probabilities have been measured for molecular chlorine upon the GaAs(100) Ga-rich c(8x2), GaAs(100) As-rich c(2x8), and GaAs(110) stoichiometric (1x1) surfaces. The sticking probability has measured as a function of incident translational energy (0.038 to 0.66 eV), surface temperature (150 K - 835 K), angle of incidence (0° to 37°), and surface chlorine coverage. Our data indicate the presence of both precursor and direct activated chemisorption mechanisms on all three surfaces. Total energy scaling is observed on both the GaAs(100) Ga-rich c(8x2) surface and the stoichiometric GaAs(110) (1x1) surface for both precursor mediated and direct activated chemisorption, indicating a highly corrugated gas - surface interaction potential. For all incident energies dosing of the 300 K GaAs(100) Ga-rich c(8x2) and stoichiometric GaAs(110) (1x1) surface results in chemical passivation; conversely dosing the 300 K GaAs(100) As-rich c(2x8) surface or the disordered GaAs(100) or GaAs(110) surfaces results in thermal etching. The chemical passivation of GaAs by Cl_2 is stable in air and may represent a significant technological advance; after the passivation layer has been further characterized for long term air stability, we will seek a patent.

Sticking probabilities of F_2, Cl_2, Br_2, I_2, and monochlorobenzene onto Si(100) 2x1 have been measured over a large range of incident conditions. The measurements show that for Cl_2, Br_2, and I_2 there is a strong precursor mediated chemisorption at low incident energies and an equally strong direct activated chemisorption at high translational energies. However, for monochlorobenzene only a precursor mediated chemisorption is observed and for F_2 no precursor mediated chemisorption is observed even at low incident energies. For all systems, the precursor states were intrinsic at 300 K not extrinsic.

For Cl_2, the sticking probability was also measured on the corrugated Si(111) 7x7 surface. These measurements show that there is a weak precursor mechanism at low incident translational energies and a direct activated chemisorption mechanism over a wide range of incident energies. To investigate the role of the chemisorption mechanism in formation of adsorbate structures, scanning tunneling microscopy and molecular beam (STM-MB) techniques were applied to investigate the nature of Cl_2 adsorption as a function of incident translational energy on the Si(111)-7x7 surface at 300 K. When a Si(111)-7x7 surface is dosed with a monoenergetic Cl_2 beam of translational energy less than 0.11 eV, the dominant adsorbate structure is SiCl islands but single site center-adatom preferred chemisorption is also observed. The SiCl islands are hundreds of Angstroms apart at low coverage and do not nucleate at step edges. Conversely, for 0.44 eV Cl_2 dosing, island formation is not observed and only single site center-adatom preferred chemisorption is present. It is proposed that center-adatom preferred reaction results from direct activated chemisorption and island formation results from precursor mediated chemisorption of Cl_2 onto the Si(111)-7x7 surface